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Global synthesis of drought effects on cereal production

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Abstract

Drought has been a major cause of agricultural disaster, yet how various factors (e.g., crop species, phenological phases) affect the vulnerability of cereal agriculture to drought remains unclear. Using a data synthesis approach, this study aims to better characterize the effects of these factors and to provide critical information on minimizing yield loss. We collected data from peer-reviewed publications between 1980 and 2015 which examined cereal yield responses to drought using field experiments. We performed unweighted analysis using the log response ratio to calculate the bootstrapped confidence limits of yield responses and calculated drought sensitivities for several key factors. Our results showed that yield reduction varied with species, with wheat having lower sensitivity to drought and yield reduction (20.6%) compared to maize (39.3%) at approximately 60% water reduction. Drought that occurred during the reproductive phase caused greater yield reduction (30%) than when it occurred during the vegetative phase (20%). While cereal cultivation in the drylands was more prone to yield loss than in the non-dryland regions, no difference was observed among sites of different soil texture. Informed by these results, we discuss possible causes and low-cost strategies that may minimize drought effect on crop yield.